U.S. Fish and Wildlife Service

Sediment Pollutant Evaluation at Priority Dam Removal Sites in North Carolina

Final report: Off-Refuge Contaminant Study 4F38

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Preface

Bewteen 2004 and 2008, the U.S. Fish and Wildlife Service and partners investigated the potential for sediment contamination at three dams in North Carolina: Lowell Dam (Little River, Johnston County), Carbonton Dam (Deep River, Moore County) and Milburnie Dam (Neuse River, Wake County). A tier 1 environmental assessment was completed for each dam to evaluate existing data on contaminant inputs to impounded reaches of each structure. At Lowell Dam and Carbonton Dam, tier 2 assessments consisting of sediment sampling and chemical analyses were also conducted. The work was completed by Sara Ward (Ecologist / Environmental Contaminant Specialist) and Tom Augspurger (Ecologist / Environmental Contaminant Specialist) in the U.S. Fish and Wildlife Service's Raleigh Field Office and was funded by the U.S. Fish and Wildlife Service's Division of Environmental Contaminants (study identifiers 4F38 and 200540001).

All study results have been provided in previous draft or final reports (listed in Table 1), and this report merely synthesizes those sources which should be referenced for detailed methods and results. Copies of each of the reports from this study can be obtained from the U.S. Fish and Wildlife Service at the following address:

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Cover photo credit: Removal of Carbonton Dam in 2005. The U.S. Fish and Wildlife Service Environmental Contaminants Program report on sediments behind the dam was used in the environmental assessment on the removal of the dam. Our on-site assessment, sampling, and reporting indicated a low risk of sediment contamination. Photo: USFWS

Sediment Pollutant Evaluation at Priority Dam Removal Sites in North Carolina - Executive Summary

North Carolina dam removal mitigation guidelines call for site-specific evaluation of sediment issues, including sediment contamination. From 2004 to 2008, the U.S. Fish and Wildlife Service worked with others to provide necessary data for three North Carolina dams being considered for removal; Lowell Dam (Little River, Johnston County), Carbonton Dam (Deep River, Moore County) and Milburnie Dam (Neuse River, Wake County). We sought to provide answers to these questions for dam owners, regulators, and other stakeholders:

1) Are there historic or existing pollutant sources of concern in the watersheds of the dams?

2) Does sediment pollution exceed guidelines indicating potential adverse impacts to biota?

3) Do pollutant concentrations within the impounded reaches of the dams differ from those downstream, which may be impacted by dam removal?

4) If sediment contaminants exceed screening guidelines, do they cause reductions in survival and growth in test species and/or unacceptable bioaccumulation of pollutants?

A tier 1 environmental assessment was completed for each dam to evaluate existing data on contaminant inputs to impounded reaches. At Lowell Dam and Carbonton Dam, tier 2 assessments consisting of sediment chemical analyses were also conducted. Components of the study have been summarized in five previous draft or final reports which should be consulted for detailed methods and study results. Some key findings include the following:

- We documented low risk of contaminant concerns if the Lowell Dam was removed. Our reports were used in the environmental assessment of the dam removal. The dam was removed by a private entity as a stream mitigation project in 2005.

- We documented low risk of contaminant concerns if the Carbonton Dam was removed. Our reports were used in the environmental assessment of the dam removal. The dam was removed by a private entity as a stream mitigation project in December 2005.

- We documented organic and inorganic pollutant concerns in the watershed upstream of Milburnie Dam. If sediment disturbing activities are proposed at the Milburnie Dam, it warrants a tier 2 sediment assessment, with an emphasis on heavy metals and hydrocarbons. A private entity has proposed removal of the dam for stream mitigation.

- There is no standard method for evaluating potential sediment contamination at dam sites, but the tiered assessment approach we employed worked well. The step-by-step approach of synthesizing existing contaminant source data, sharing that with stakeholders for a discussion on how to proceed, and collecting site-specific sediment data if necessary effectively and efficiently addressed concerns of regulated and regulatory communities. This approach is recommended as a foundation for future dam removal assessments.

Key words: North Carolina, dam, dam removal, sediment, environmental assessment, Milburnie, Carbonton, Lowell, elemental contaminants, heavy metals, hydrocarbons

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INTRODUCTION

Impoundments are well recognized stressors to many species of riverine fishes, amphibians, mussels, crayfishes, and insects (Richter et al. 1997). Neves et al. (1997) and Watters (2000) reviewed effects of impoundments on freshwater mollusks, noting flow changes, population fragmentation, water quality problems and sediment issues. Dams also alter normal nutrient dynamics of riverine systems (Freeman et al. 2003) and can degrade water quality within the impounded reach as well as downstream (Arnwine et al. 2006). Removal of dams can restore lotic habitat and improve water quality for a variety of species. Dam removals can be conducted with high environmental rewards and low environmental risks if structural, operational, and seasonal controls to manage sediment transport are applied (Riggsbee 2006). A decision to proceed with removal needs to be based on a case-by-case assessment of environmental and economic costs and benefits. One issue among the many to consider in evaluating dam removal is the chemical nature of the sediments accumulated behind the dam.

Dams typically create a quiescent environment in the impounded reach, establishing conditions favorable for sediment deposition. Impounded reaches behind some dams accumulate silt and detritus, and many contaminants have a strong affinity for these sediments (Anderson et al. 1987; Rodgers et al. 1987). Sediment-associated contaminants can impair surface waters and associated aquatic life in-place and, if disturbed, upon mobilization and transfer of water-soluble pollutants to the water column. The degree of the concern is a function of site-specific pollutant loading based on age and size of the dam and pollutants discharged into the watershed. In North Carolina, dam removal guidance (U.S. Army Corps of Engineers et al. 2008) notes the need to evaluate contaminants at dams proposed for removal on a case-by-case basis. However, there are no regulations that define the evaluation approach. So dam owners are reluctant to conduct expensive testing without a certain regulatory framework, and the lack of a framework hampers efforts to manage analytical costs. These issues can delay efforts to restore aquatic habitats.

From 2004 to 2008, we tackled this issue for three North Carolina dams being considered for removal; Lowell Dam (Little River, Johnston County), Carbonton Dam (Deep River, Moore County) and Milburnie Dam (Neuse River, Wake County). We obtained U.S. Fish and Wildlife Service Environmental Contaminants Investigation funding to assess each dam in order to provide answers to these questions for dam owners, regulators, and other stakeholders:

1) Are there historic or existing pollutant sources of concern in the watersheds of the dams?

2) Do sediment pollutants exceed guidelines indicating potential adverse impacts to biota?

3) Do pollutant concentrations within the impounded reaches of the dams differ from those downstream, which may be impacted by dam removal?

4) If sediment contaminants exceeds screening guidelines, do they cause reductions in survival and growth in benthic and surface water test species (used as surrogates for native fauna) and/or unacceptable bioaccumulation of sediment-bound contaminants?

We used the framework of the U.S. Environmental Protection Agency / U.S. Army Corps of Engineers (USEPA/USACE 1998) technical guidance manual on disposal of dredged material in inland waters with additional guidance from sediment assessment manuals (MacDonald and

Ingersoll 2002a, 2002b). Evaluations start with a tier 1 assessment (using existing information to assess the potential for a contaminated sediment concern) and proceed in a step-wise fashion through tiers 2 (surface water and sediment chemistry), etc. only to the extent necessary to address site-specific issues. All assessments started with tier 1; they could end there or proceed to higher tiers if additional data were needed. In general, absence of pollutant sources would indicate little need for aggressive work to characterize potential contaminants. Likewise, any sampling became guided by specific issues identified in the tier 1 reviews.

Our tier 1 assessments (process outlined in Appendix A) started with database and file searches to examine the potential for contaminant inputs to the impounded reaches. We defined an assessment as the stream-reach impounded by each dam, plus a one-mile buffer laterally and upstream. This approach is consistent with guidance on environmental audits (ASTM 2005). We reviewed facility and site files to gather information on pollutants discharged, potential contaminant pathways to assessment areas, and environmental monitoring data. We conducted a reconnaissance of each site, interviewed staff knowledgeable of the study sites, and prepared a draft report (with maps of identified pollutant sources, facility lists, and a summary of the subset of issues we thought needed additional evaluation) for stakeholder review. Follow-up tier 2 sediment collection, chemical analyses, and reporting was performed at two dam sites.

FINDINGS

Five reports (Table 1) summarize the major components of the study. While readers are referred to those reports for detailed methods and results, the significant conclusions from work at each of the dams is summarized below.

Table 1. Reports[a] associated with the U.S. Fish and Wildlife Service and partners' Environmental Contaminant Program study on contaminant issues associated with potential dam removals in North Carolina

Augspurger, T.P. and S.E. Ward. 2008. *Tier 1 Preliminary Evaluation of Pollutant Sources to the Impounded Reaches of Five Dams in the Neuse River Basin, North Carolina*. U.S. Fish and Wildlife Service, Raleigh, NC.

U.S. Fish and Wildlife Service. 2004. *Draft Tier 1 Preliminary Evaluation of Sediments within the Lowell Dam Impounded Reach, Johnston County, North Carolina*. USFWS, Raleigh Field Office, Raleigh, NC.

U.S. Fish and Wildlife Service. 2005a. *Draft Preliminary Evaluation of Sediment Chemistry Data (Tier 2) for Little River near Lowell Dam*. USFWS, Raleigh Field Office, Raleigh, NC.

U.S. Fish and Wildlife Service. 2005b. *Draft Tier 1 Preliminary Evaluation of Sediments within the Carbonton Dam Impounded Reach, Moore County, North Carolina*. USFWS, Raleigh Field Office, Raleigh, NC.

U.S. Fish and Wildlife Service. 2005c. *Preliminary Evaluation of Sediment Chemistry Data (Tier 2) for Deep River near Carbonton Dam.* USFWS, Raleigh Field Office, Raleigh, NC.

[a] Copies can be obtained from the U.S. Fish and Wildlife Service in Raleigh, NC

Lowell Dam, Johnston County, Little River

Lowell Dam was located on the Little River in Johnston County, North Carolina approximately one quarter mile east of I-95. The dam was built in 1914, and was 11-feet high and 220-feet long. Its run-of-river design resulted in a relatively small impoundment, and it affected about 6.5 miles of stream including mainstem Little River and tributaries.

In 2004, we conducted a tier 1 review of existing information which indicated no significant point or nonpoint pollutant sources upstream of Lowell Dam. Minor concerns included highway run-off from I-95, the Kenly wastewater treatment plant, and the disposal of several automobile batteries within the stream near Highway 301. We noted that the sand, gravel, bedrock nature of the sediments in this portion of the Little River likely had little affinity for accumulation of pollutants from these sources (which would instead be transported in surface waters and suspended sediment). This has been observed at other small dams (Ashley et al. 2006). While no major concerns were noted in the review, we recommended that sediment quality data be collected to support management decisions. Those data were to focus on heavy metals and hydrocarbons in sediment to address the minor concerns from highway run-off and battery disposal. We prepared a draft sampling plan for consideration by stakeholders (USFWS 2004).

Tier 2 sampling commenced in April 2004 with five sediment samples collected from within the impounded reach of Lowell Dam and two samples downstream. All were analyzed for elemental contaminants and polycyclic aromatic hydrocarbons. Threshold effects concentrations (TECs) and probable effects concentrations (PECs) were used to assess the signficance of the sediment chemistry results. The TECs are concentrations of contaminants in whole sediment below which adverse effects to sensitive aquatic organisms are not expected to occur, and the PECs are effect-based sediment quality guidelines established as concentrations of contaminants in whole sediment above which adverse effects are expected to frequently occur in field-collected sediments (MacDonald et al. 2000). At and downstream of the dam, eighty-eight percent of all elemental contaminant results were less than TECs and are therefore considered toxicologically insignificant. No samples exceeded the PECs for any elemental contaminant. About 12 percent of the sample results fell between the TEC and PEC screening values and they were further evaluated by comparing their magnitude to the geometric mean of the screening values. No elemental contaminant concentrations exceeded these median values. Polycyclic aromatic hydrocarbons were not detected in any sample. Review of existing data and an on-site assessment (tier 1) and results of sediment chemistry (tier 2) indicated no additional sediment analyses were needed (USFWS 2005a).

The information provided in our assessments helped inform dam owners, regulators, and other stakeholders in the ultimate removal of Lowell Dam in 2005 (Riggsbee et al. 2007) (Figure 1). The removal of Lowell Dam restored access to 102.5 miles (16.5 miles on the mainstem and 86 miles of tributaries) of spawning habitat for six species of anadromous fish. Populations of the federally-listed endangered dwarf wedge mussel (*Alasmidonta heterodon*) and the federally-listed endangered Tar River spinymussel (*Elliptio steinstansana*) have been found in the Little River upstream of the project area. Additionally, populations of dwarf wedge mussel have been found downstream. These species require flowing water, and removal of the dam may allow reoccupation of the impounded reach, re-establishing genetic exchange between upstream and downstream populations.

Figure 1. The removal of Lowell Dam on the Little River (top image) in 2005 restored access to 102.5 miles (16.5 miles on the mainstem and 86 miles of tributaries) of spawning habitat for six species of anadromous fish. The dam was removed by Restoration Systems, LLC. for the North Carolina Ecosystem Enhancement Program. Biologists with North Carolina State University installed fish sampling gear at the footprint of the old dam (bottom image), and they have documented the passage of the American Shad during spawning seasons in 2006 and 2007. Service Environmental Contaminants Program reports (USFWS 2004, 2005a) documented low risk of contaminant concerns if the dam was removed, and the reports were used in the environmental assessment of the dam removal.

Carbonton Dam, Moore County, Deep River

Carbonton Dam was built in the early 1900's (Restoration Systems, LLC and EcoScience Corp 2005). In 2005, we conducted a tier 1 review of pollutant sources upstream of Carbonton Dam. Record searches and file reviews indicated no hazardous material concerns within the impounded reach or a sizeable buffer. Also, it appeared that land uses upstream and downstream of the reservoir were similar and that any mobilized sediments from behind the dam may merely subject downstream areas to the same sources of contaminants to which they have been historically exposed. Although an argument could be made that additional testing was not necessary based on the tier 1 assessment, we recommended a limited tier 2 study to generate data on the sediments behind the dam. None of the sediment data we reviewed during the tier 1 effort (Howard 2003) was for the impounded reach, and sampling there was encouraged to provide more specific data to support the inference of low contaminant burdens (USFWS 2005b).

Seven sediment samples from within the impounded reach of Carbonton Dam were collected in October 2005 and analyzed for elemental contaminants. Ninety-six percent of all elemental contaminant results were less than TECs (MacDonald et al 2000) and were therefore considered toxicologically insignificant. No samples results exceeded the PECs. Two of the seven nickel results (or about four percent of the overall sample results) fell between the TEC and PEC screening values, but they were at or below the geometric mean of the screening values. Based on review of existing data (tier 1) and results of sediment chemistry (tier 2), contamination in surface sediments behind Carbonton Dam was considered unlikely to be a concern, and no further sediment analyses were deemed necessary (USFWS 2005b, 2005c).

The information provided in our assessments helped inform dam owners, regulators, and other stakeholders prior to removal of Carbonton Dam in 2005 (Figure 2). The removal restored natural hydrology to the Deep River for about 9 miles and made this habitat suitable for native species, including the federally-endangered Cape Fear shiner (*Notropis mekistocholas*). The removal of the dam eliminated a barrier between upstream and downstream populations of Cape Fear shiner; since removal, the species has been found in the previously impounded reach.

Figure 2. The 17 feet high and 270 feet long Carbonton Dam (top image) created a 9-mile impoundment on the Deep River. The dam had been linked to water quality problems and negatively impacted habitat for the federally-listed endangered Cape Fear shiner (*Notropis mekistocholas*). In 2005, Restoration Systems, LLC removed the dam (bottom image) restoring portions of the Deep River and tributaries to their free flowing initial character. Service Environmental Contaminants Program reports (USFWS 2005b, c) examining the potential for contaminant concerns in sediments behind Carbonton Dam were provided to the multi-agency North Carolina Dam Removal Task Force and used in the environmental assessment on the removal of the dam.

Milburnie Dam (Bridges Lake Dam), Wake County, Neuse River

Milburnie Dam (Figure 3) is located inside the Raleigh city limits. The dam has a small hydroelectric plant and the watershed is relatively undeveloped locally but extensively developed (US1 and US401 corridors) further upstream. The dam is about 13-feet tall and creates a significant impoundment on the Neuse River. Milburnie Dam was designated as a priority for removal by the interagency North Carolina Dam Removal Task Force, most notably because it is a known barrier for two anadromous fishes and has been associated with water quality concerns.

Figure 3. Milburnie (Bridges Lake) Dam, Wake County, Neuse River (USFWS photo)

Our tier 1 review of existing information (Augspurger and Ward 2008) indicated no known significant organic or inorganic pollutant problems in a one-mile assessment area surrounding the impounded reach of Milburnie dam. Potential pollutant sources include two large municipal and one industrial facility having documented controlled or uncontrolled releases of pollutants within the assessment area. Highway run-off is a concern for the assessment area as well, and biological monitoring data indicate impairment of the benthic communities in the watershed, attributed to urbanization influence. If sediment disturbing activities are proposed at the Milburnie Dam assessment area, it warrants additional data collection (i.e., a tier 2 assessment), with an emphasis on heavy metals and hydrocarbons to address urban run-off and other sources.

We presented a draft sampling and analysis plan for review by stakeholders. An option on Milburnie Dam has been secured by a private entity which has proposed to remove it as a stream mitigation project (Restoration Systems, LLC 2009). Their proposal references the Service's tier 1 sediment quality evaluation and follow-up recommendations (Augspurger and Ward 2008).

ACCOMPLISHMENTS AND MANAGEMENT RECOMMENDATIONS

This study began in 2004 to provide stakeholders with site-specific data on three dams being considered for removal. The work was highly successful with the following accomplishments:

- Service Environmental Contaminants Program reports (USFWS 2004, 2005a) documented low risk of contaminant concerns if the Lowell Dam was removed. Our reports were used in the environmental assessment of the dam removal. The dam was removed by a private entity as a stream mitigation project in 2005.

- Service Environmental Contaminants Program reports (USFWS 2005b, 2005c) documented low risk of contaminant concerns if the Carbonton Dam was removed. Our reports were used in the environmental assessment of the dam removal. The dam was removed by a private entity as a stream mitigation project in December 2005.

- A Service Environmental Contaminants Program report (Augspurger and Ward 2008) documented organic and inorganic pollutant concerns in the watershed upstream of Milburnie Dam. If sediment disturbing activities are proposed at the Milburnie Dam, it warrants a tier 2 sediment assessment, with an emphasis on heavy metals and hydrocarbons (markers of urban run-off and other sources). A private entity has proposed removal of that dam as a stream mitigation project.

- There are no regulations or standards that dictate the approach to be used in evaluating potential sediment contamination at dam sites, but the tiered assessment approach we synthesized from several sediment evaluation guides (USEPA/USACE 1998, MacDonald et al. 2000, MacDonald and Ingersoll 2002a, 2002b) and environmental audit resources ASTM 2005) worked well. The step-by-step approach of synthesizing existing contaminant source data, sharing that with stakeholders for a discussion on how to proceed, and collecting site-specific sediment data if necessary effectively and efficiently addressed sediment concerns for the regulated and regulatory communities. The tier 1 approach we used is outlined in Appendix A; it is recommended as a foundation for dam removal assessments. Depending on the tier 1 results, tier 2, 3 or 4 assessments can be designed and implemented as needed.

- In addition to informing others on the three dams we studied, the project generated interest and action in evaluating sediments at other dams in North Carolina (Augspurger and Cantrell 2004, USFWS 2006, Augspurger et al. 2007, Augspurger and Ward 2008). We started a new sediment evaluation project with three dams on the Haw River in 2008.

- In addition to dam reviews we have conducted since 2004, we have helped others with their own tier 1 and tier 2 assessments, effectively training others via Service technical assistance made possible by this project.

Our expertise and equipment in the field, close to where Lowell, Carbonton and Milburnie dams were located, made us a valuable partner for the teams of stakeholders needing site-specific evaluations of sediment pollutant issues at these dams.

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Appendix A

USFWS Raleigh Field Office Tier 1 Evaluation Methods

1) Our tier 1 evaluation starts with database searches to examine the potential for contaminant inputs to the assessment area. We typically define an assessment area as the project areas plus a one-mile buffer laterally and upstream (some known major sites located outside the buffer are also considered). This approach is consistent with the American Society of Testing and Materials *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM 2005).

There are a lot of facility databases to check, some of which are easier to search than others because they compile data from multiple databases (instead of starting by looking at each database individually). Here's what we do:

a) We use *BasinPro8*, a product of the North Carolina Center for Geographic Information and Analysis (NCCGIA), which has a data layer called 'Hazardous Substance Disposal Sites (hsds.shp) (http://www.nconemap.com/nconemap_meta/hsds_faq.htm). That data layer includes information from CERCLA Information System (CERCLIS) National Priorities List, and some of the State databases for known or suspected hazardous waste sites. We also call up data layers for permitted point source waste discharges to surface water (npdes.shp), land application sites (slandpp.shp), and registered animal waste operations (nc_animal_ops.shp).

b) We use USEPA's *Envirofacts Database* (which searches facilities with air and water waste discharge permits, solid or hazardous waste sites, and facilities handling hazardous materials). This is a large clearinghouse of EPA data
http://www.epa.gov/enviro/

c) We use USEPA's Geospatial Data Access Project (http://www.epa.gov/enviro/geo_data.html) for spatial data on a variety of pollutant sources

2) Those resources are used to help make a geographic information systems (GIS) map of the sites of potential interest.

3) For additional detail on those sites and for completeness, we also look at these databases:

a) We search (by county) the Toxics Release Inventory (TRI), an EPA database that contains information on toxic chemical releases and waste management activities reported annually by certain industries as well as federal facilities. This has much more specific information on the pollutants released and their quantities
http://www.epa.gov/tri/

b) We examine some other databases and files maintained by State and federal natural resource management agencies, particularly North Carolina Division of Waste Management (NCDWM; a list of the NCDWM databases is at http://www.wastenotnc.org/DATARPTS2003_3ColA.HTM), and North Carolina Division of Air Quality. The databases we check in particular (because they do not seem to be captured by the previous tools) include:

Inactive Hazardous Waste Sites
http://www.wastenotnc.org/SFHOME/IHS_County_List.pdf

Old Landfills
http://www.wastenotnc.org/SFHOME/IHS_Landfill_List.pdf

Underground Storage Tank Incidents http://www.wastenotnc.org/ust/database.html#ST
(Regional UST Database download)

NC Division of Air Quality Emissions Inventory
http://xapps.enr.state.nc.us/aq/ToxicsReport/Toxrpt.jsp?ibeam=true

Collectively, the above mapping tools and databases retrieve known information from the following primary sources (while we begin to notice a lot of redundancy if checking these individually, they are listed here as individual links for more information on particular sites).

National Priorities List (Superfund Sites)
http://www.epa.gov/region4/waste/npl/index.htm#NC
- but we use Envirofacts which gets these data

Inactive Hazardous Waste Sites
http://www.wastenotnc.org/SFHOME/IHS_County_List.pdf

Old Landfills
http://www.wastenotnc.org/SFHOME/IHS_Landfill_List.pdf

Active Solid Waste Permits
http://www.wastenotnc.org/sw/swfacilitylist.asp?STATUS=OPEN

CERCLIS Sites (known or suspected unregulated waste sites)
http://www.epa.gov/superfund/sites/cursites/index.htm
- but we use Envirofacts which gets these data

Resource Conservation and Recovery Act Sites
(hazardous waste generation, transport, disposal)
http://www.wastenotnc.org/sw/swfacilitylist.asp?STATUS=OPEN
- but we use Envirofacts which gets these data

National Pollutant Discharge Elimination System Sites
(NPDES, surface water discharge sites)
- searched in Envirofacts

Sewage Sludge Land Application Sites
- searched in Basin Pro

Underground Storage Tanks Incidents
http://www.wastenotnc.org/ust/database.html#ST

Aerometric Information Retrieval System (AIRS)

http://www.epa.gov/enviro/html/airs/airs_query_java.html

- but we use Envirofacts which gets these data

Toxic Release Inventory

http://www.epa.gov/tri/

NC Division of Air Quality Emissions Inventory

http://xapps.enr.state.nc.us/aq/ToxicsReport/Toxrpt.jsp?ibeam=true

4) From the above databases and on-line resources, we can usually rule-out or rule-in sites for additional evaluation. For those that need more inquiry, we look at hard copy files at the central (Raleigh) offices of NCDWM and NCDWQ. File reviews gather information on pollutants discharged from the facilities, potential contaminant pathways from facilities to assessment areas, and environmental monitoring data for the facilities.

5) We review environmental studies prepared by others (NCDWQ, USGS, local universities, etc.) with an emphasis on water and sediment chemistry. The NCDWQ basinwide assessment reports are updated every 5-years and are good summaries.

6) We conduct a reconnaissance of each site.

7) We interview staff knowledgeable on the landuses and history of the study sites, if possible.

8) We prepare a draft report (with our maps, facility lists, and summary of the subset of any issues we think need additional evaluation) and seek external review by NCDWM and NCDWQ personnel in the local / regional office of the assessment area.

9) Final report makes recommendation to stakeholders based on the findings of the tier 1 review.

Reference:

ASTM International. 2005. Standard practice for environmental site assessments: Phase I environmental site assessment Process (E1527-05). *ASTM International Annual Book of Standards*, West Conshohocken, PA.